# SUBPARIETAL RUPTURE OF THE KIDNEY.

By THOMAS A. DAVIS, M.D.,

OF CHICAGO,

PROFESSOR OF SURGERY, COLLEGE OF PHYSICIANS AND SURGEONS; SCHOOL OF MEDICINE OF UNIVERSITY OF ILLINOIS; PROFESSOR OF SURGERY, CHICAGO CLINICAL SCHOOL.

RECENTLY I have had to treat a case of subparietal rupture of the kidney, and, insomuch as a definite line of treatment of these cases has not been settled upon, I desire to add my experience in this case to those already recorded, and, at the same time, briefly to review the literature which has accumulated since the most valuable contribution on this subject from W. W. Keen, in 1896.[1]

The statement that the mortality of subparietal rupture of the kidney is greater than that of gunshot wounds of that organ, and over four times as great as from nephrectomy in general,[2] seems paradoxical, but, nevertheless, it is true; and I think it may be incontrovertibly said that it is because the wisdom of the masters has not been disseminated generally among the profession.

It is to reiterate the teachings of Küster,[3] Tuffier,[4] Grawitz,[5] Maas,[6] Keen,[1] Fenger,[7] Morris,[8] and others, in regard to the early operative treatment, and to emphasize the importance of their conclusions, and not to offer suggestions of my own, that I enter into this subject.

The series of cases comprising my report commences from the beginning of 1897, from the time of Keen's report, and includes the year 1901, a period of five years. In some of the cases the reports are not complete, but sufficient evidence is manifest to confirm the conclusions of the authors mentioned.

I will first give the history of my own case, which is briefly as follows:

The patient, H. P., aged eighteen years, was referred to me by Dr. I. N. Albright, of this city, on September 29, 1901.

He is a young man of excellent family history, with no previous illness nor bad habits; a rough rider, of athletic build, whose appellation was derived from his being a member of the volunteer rough riders cavalry corps of this city.

He was injured while engaged with his company in the drill of mounting and dismounting horses. He was standing behind his horse when he received a severe kick from it in the right side of the abdomen, which knocked him down and rendered him momentarily unconscious. He suffered violent pain in the abdomen and loin, and could not move because of its exacerbation. He was picked up by his comrades, carried to a vehicle, and taken home. Dr. Albright was called at once, and he administered morphine to relieve pain. The chief symptoms observed up to the time when I first saw the case were: bloody urine, frequent and severe vomiting, which at first was of stomach contents, and in forty-eight hours became a brownish liquid of fæcal odor; constipation, which did not yield to calomel and salines per mouth and numerously repeated rectal injections, and severe, spasmodic pains in abdomen.

Dr. Albright had made the diagnosis of injury to the kidney. On my first examination, the patient presented the appearance of being very ill and suffering severely. He was lying, slightly inclined to his left side, with his right thigh flexed on the abdomen, which was distended, tympanitic, rigid, and very sensitive to palpation over the right side. His bowels had not moved. He had vomited frequently that day, and the last three times the vomitus had a fæcal odor. There was fulness in the ileocostal space and great tenderness on pressure in the loin. His pulse was 118; temperature, 101° F.; and respirations, 28.

I advised sending him at once to the hospital, which was done, and I operated upon him one and a half hours later, at 2.10 P.M. (He left the operating-room at 4.) Chloroform was the anæsthetic used.

The incision was made through the right linea semilunaris, over the part said to have been about the seat of the impact of the horse's foot. There was no external evidence of injury.

On opening the abdomen, a small amount of gas and bloody fluid emerged. Laparotomy sponges were used and the fluid partly removed. Inspection showed the ascending colon to be enormously ballooned, livid, and with a rupture of the peritoneum over its anterior or free surface. The lacerated wound was about two inches in length and parallel with the long axis of the gut. The muscularis was slightly torn and presented a bruised appearance. There was oozing of dark blood from the wound surface.

The dark outline of the kidney could be seen, and palpation elicited fluctuation around it. The peritoneum was not torn. The only evidence of peritonitis was a slight fibrinous exudate on the colon for a short distance about the wound.

The abdominal cavity was wiped out with laparotomy sponges. The tension and contusion of the colon tissue forbidding suture, five strips of iodoform gauze were placed as follows: Two over the wound of the colon to relieve the oozing and to provide drainage in case of subsequent perforation of the gut; the others in the most dependent part of the peritoneal cavity. The uncertainty of the extent of the intestinal injury and the presence of gas in the peritoneal cavity seemed to me to demand drainage, although no macroscopical change of the peritoneum was discernible excepting that referred to, immediately surrounding the wound.

The abdominal wound was partially closed with the figure-of-eight silkworm-gut sutures. The patient was then placed on his left side in a Turner kidney saddle, and a nephrotomy done through the usual incision in the ileocostal space. The perirenal capsule bulged into the wound. It was opened and a considerable quantity of clots and fluid escaped. The sac was wiped out and the kidney inspected. There was a deep wound about the middle of the kidney extending through the anterior surface from near the convex border into its pelvis.

A rubber drainage tube was introduced into the wound, and a few strips of iodoform gauze were packed around it to check the hæmorrhage, which was not profuse. The external wound was sutured with silkworm gut. A voluminous dressing was applied, and the patient taken to his bed.

*Subsequent History.*—Tubage at once relieved the colon from the gaseous distention. No food was taken into the stomach for five days. Saline enemata resulted in slight bowel movement, with free escape of flatus, in twenty-four hours; fair bowel movement in thirty-six hours. Nutrient enemata given for five days. Gauze packing removed from abdomen after thirty-six hours. Disappearance of all serious symptoms in seventy-two hours.

October 14. Tube removed from kidney (the sixteenth day); at that time patient's urine passed from the bladder was normal. His temperature was 98.6° F.; pulse, 70, and remained so for ten days; the discharge from the wound grew less each day.

October 24. Intern injected fistula with iodine, for some inexplainable reason. It provoked attack of great pain in loin, radiating down to groin and to the bladder. Temperature, 102.2° F.; pulse, 120; respirations, 26, four hours later.

October 27. I had been out of the city for one week, and Dr. Bayard Holmes kindly took charge of the case in my absence. The temperature and discomfort continuing, Dr. Holmes slightly reopened old tract under Schleich's local anæsthesia. Some blood and pus escaped. Rubber tube and gauze drain inserted.

October 29. Temperature, 99° F.; pulse, 76; patient more comfortable.

November 11. For past week patient has had temperature rising as high as 103°, accompanied by severe renal colic. I reopened kidney (the patient under chloroform) and removed two disintegrating clots from kidney pelvis, and reinserted tube and gauze.

November 13. Temperature, 98.6°; pulse, 80.

November 18. For the past week patient has had severe pain of a neuralgic character, deeply seated in the umbilical region, requiring frequent hypodermic injections of morphine. Refuses food. Pulse becoming more frequent. Urine contains pus. Nephrectomy.

*Operation.*—Incision through old scar down to kidney, which was liberated from its attachments. The vessels and ureter were ligated with catgut just below the hilus and severed. There was some bleeding. Two hæmostatic forceps were placed on stump, and both angles of the wound were closed with silkworm-gut sutures.

November 19. Pulse, 126; temperature, 98°.

November 20. Pulse, 114; temperature, 100°.

November 21. Pulse, 90; temperature, 98.6°. Pain wholly disappeared. Urine showed trace of albumen and a few pus cells. For days following the nephrectomy, the dressings were saturated with urine and the urine passed from the bladder in but small quantities. A solution of methylene blue was injected into the bladder, and it passed through the ureter and stained the dressings.

November 26. Urine shows slight trace of albumen.

December 22. Left the hospital. Fistula tract closed; urine normal; patient able to walk about, feeling quite well.

*Pathological Findings.*—Macroscopically, the kidney showed exceedingly slight change, and that only at the seat of the wound. About this region there was an area of slight pressure necrosis from the drainage tube. The pelvis epithelium was clear, the pelvic wall not thickened. The fistulous tract was small. There were no pockets about the kidney, and the kidney itself was not enlarged. From the appearance of the kidney after its removal, it seems almost an unnecessary sacrifice to have removed it. It is probable that if the drainage had been adequate and the clots removed, and if the iodine injection had been omitted, the nephrectomy would not have been done. But the general condition of the patient became so bad, and there was uncertainty as to the pathological condition which occasioned his suffering after free drainage had been effected, so it seemed imperative to remove the kidney without further delay, while the patient had still the strength to withstand the operation.

At no time was there anuria, nor a very greatly diminished secretion of urine. Often-repeated urine analyses are recorded on the history sheets, but there is nothing important in them.

Of the thirty-four cases which I have collected from the literature, the abstracts in brief are as follows:

Case I.—Johnson.[9] Blow over left side; sharp local pains; admitted to hospital immediately. Symptoms of internal hæmorrhage; left loin tender, swollen, dull below ribs; blood urine. Second day, temperature, 102.3° F.; third day, 104.6° F.; condition bad.

*Operation.*—Lumbar incision. Large hæmatoma; left kidney completely torn through middle. Nephrectomy, drainage. Uneventful recovery. Kidney almost pulpefied.

Case II.—De Kammerer[10] reports case with diagnosis of perinephritic abscess. Upon operation, found ruptured kidney. Nephrectomy. Recovery.

Case III.—Hughes.[11] Car-crushing injury; profound shock; urine almost pure blood. After eighteen hours, urine clear. Died, peritonitis, three days after injury. Post-mortem; kidney torn completely through at pelvis; large extravasation around kidney; intestines not injured; spleen lacerated.

Case IV.—Nash.[12] Boy kicked by horse, about tenth rib. Immediately severe pain in right side, at lower edge of ribs. Tenderness anterior and posterior; eight hours afterwards passed "porter-colored" urine; after forty-eight hours, urine clear. Fulness in flank and expected peritoneal injury. Pulse rapid; temperature, 101.4° F. Condition bad. Operation on sixth day. Lumbar incision; black clot beneath aponeurosis, loose piece of detached kidney found, and kidney itself lying in mass of blood and *débris.* Cavity washed out; three-eighths of kidney destroyed. Clean incision in kidney extending just to the pelvis. Free irrigation, drainage,—gauze and tube and suture; convalescence uneventful.

CASE V.—Link.[13] Man kicked by horse, right kidney region. Walked into soldiers' quarters; great pain in right side; immediately passed bloody urine; symptoms of shock, subnormal temperature; pain in right side, abdomen, and right testicle; dulness almost to Poupart's ligament on right side; vomiting bile-colored fluid. Right side packed with ice-bags. Improvement under treatment for twenty days; at times passed bloody urine. Sudden rise of temperature; pleurisy, with exudate in right side. Condition grew worse, and operated forty days after injury.

Lumbar incision, opened large abscess. Kidney torn completely in halves and lower half split; upper half healthy, lower necrotic; removal of lower half of kidney, suture of pelvis, and gauze pack. Temperature remained high and condition not improved after ten days, second operation and remainder of kidney removed; recovery.

CASE VI.—Wheeler.[14] Child run over by cart. For one hour after admission to hospital, plays on floor, with no symptoms. Showed sudden weakness and collapse, and died within three hours.

*Post-mortem.*—Three wide tears in right kidney and three in liver. Child had passed urine after admission to hospital, with no traces of blood.

CASE VII.—Brockman.[15] Man kicked by horse. No external wound. Slightly bloody urine at first.

*Operation.*—Lumbar incision; kidney completely divided; artery not injured, but ureter destroyed. Packed and drained. Death two days later.

CASE VIII.—Injury coasting. One hour later, pain in right side and in testicle; two hours later passed bloody urine; after twelve hours, very anæmic; tense tumor over right kidney.

*Operation.*—Kidney surrounded with blood; rent from pelvis, half-way through organ. Packed with gauze; healed completely in six weeks.

CASE IX.—Heaton.[16] Boy fell about six feet, striking over a bar. Put to bed; vomited, but felt fairly well. Several hours afterwards passed pure blood, and showed signs of hæmorrhage and collapse. Pulse, 95; temperature, 96° F.

*Operation.*—Abdominal incision in right semilunaris. Peritoneum contained much blood. Irregular rent in right kidney and in peritoneum over it. Kidney removed and hæmorrhage continued; rent found in lower surface of liver; liver wound packed; patient in collapse.

For first five days, condition good; then in next ten days, symptoms of anæmia, and temperature. Abscess, with bile and pus drained in bed of kidney. Recovery.

CASE X.—Rogers.[17] Girl fell four feet; little discomfort until following morning. Brought to hospital; not seen by author until twenty hours later. Found feeble pulse, sighing respiration and collapse; passed almost pure blood; fulness and tenderness in right lumbar region.

*Operation.*—Lumbar incision. Kidney surrounded with blood, double tear diverging from hilum. Nephrectomy and packing of wound. Patient did not recover from shock.

CASE XI.—Paton.[18] Man fell while walking, striking left side on a box. Walked home; much pain and vomiting; came to hospital a few hours later. Faintness; temperature, 100.2° F. Fracture of left twelfth rib; abdomen not distended; perhaps slight increase in dulness in both flanks; urine slightly bloody. Next day, condition same. No blood in urine; bowels moved; temperature under 100°; abdomen distended; flank dulness movable; passed thirty-eight and one-third ounces of urine in twenty-four hours. For next twelve days, no blood in urine, condition improving; sat up, had no pain, and passed about forty ounces of urine a day.

On twelfth day, pain in left loin; distinct tumor, dull, elastic, and extending down to iliac fossa; pain down course of ureter; urine normal; next day, swelling and pain increased. Incision into left loin, below level of usual kidney incision, opening perinephritic tissue. Two pints of clear, urinous fluid escaped; cavity extended to brim of pelvis and to kidney above; no opening into kidney, ureter or peritoneum found. Tubular drain. Drained for sixteen days. Complete healing.

CASE XII.—Bernays.[19] Fall against wagon-wheel: pain severe; percussion dulness over right side; urine bloody.

*Operation.*—Kidney in large hæmatoma; entirely loose; vessel torn across, but not bleeding; ureter intact. Nephrectomy; drainage; recovery.

CASE XIII.—Trimble.[20] Man fell from train; twelve hours later, severe shock, vomiting, pain in kidney region extending along course of ureter to bladder; pain in testicle; urine bloody, with wormlike clots; bladder washed out. Recovery after six weeks.

CASE XIV.—Hersey.[21] Fall thirteen feet; no external injury; shock severe; pain in right lumbar region; bloody urine; abdomen distended.

*Operation.*—Abdominal; no injury to intestines; abdomen filled with blood. Lumbar incision; kidney ruptured below pelvis; nephrectomy; death from shock; operation thirty-six hours after injury.

CASE XV.—Struck by timber. Severe pain, bloody urine, flatness extending from eighth rib behind to iliac crest.

*Operation.*—Lumbar incision; eight ounces of blood in retroperitoneal space; kidney with wide, gaping tear; nephrectomy; recovery.

CASE XVI.—Rutherford.[22] Patient admitted to hospital twenty-four hours after injury from wagon-wheel. Bloody urine; pain all over abdomen; dulness over right side; no bulging: pain constant and severe; no shock; temperature, 101.2° F. Operation next day. Lumbar incision; kidney torn across and separated from artery and vein. Nephrectomy; recovery.

CASE XVII.—Troyman.[23] Rupture of kidney; nephrectomy; recovery.

CASE XVIII.—Gardinier.[24] Soldier kicked by horse; walked part way to hospital; no external wound; severe pain in left loin; passed bloody urine several times; died same day.

*Post-mortem.*—Rupture of left kidney and spleen; capsule of kidney ruptured and kidney torn into two nearly equal halves. Rupture in lower end of spleen.

Case XIX.—Kolliker.[25] Patient fell short distance. Bloody urine and pains extending to bladder. Seen first on fourth day. Urine still slightly bloody; fifth day, urine clear; sixth and seventh days, slightly bloody; eighth day, urine clear and rise of temperature. On ninth day, œdema, with severe pains in left side. Condition growing worse; high fever and anuria.

Operation on tenth day. Region of kidney and its capsule œdematous, infiltrated with blood and urine; broad tear between middle and upper third. Irrigation and packing. Healed completely in seven weeks; no urine discharge after five and a half weeks.

Case XX.—Franz.[26] Rupture of kidney from muscle contraction. Bloody urine and pain. Recovery without operation.

Case XXI.—Rupture of left kidney from fall. No bloody urine for seventy-two hours; then urine became bloody, with other symptoms of kidney rupture. Recovery with secondary nephritis. No operation.

Case XXII.—Mudd.[27] Fall of six feet, striking right side; profound shock; bloody urine; condition good for fourteen days, then appearance of tumor in right side. Incision next day, with discharge of bloody fluid. Patient died twenty-one days after injury.

*Post-mortem.*—Tear in middle of kidney, half-way through its body.

Case XXIII.—Fall from sled. Shock profound; bloody urine within few hours; clear after eighteen hours. Tumor in right side from crest of ilium to liver, and extending to median line. Condition good for thirty hours; later, temperature, 101° F.; pulse, 140.

*Operation.*—Lumbar incision; retroperitoneal space filled with blood; kidney lacerated; nephrectomy; recovery.

Case XXIV.—Injury from wagon-wheel. Shock profound; bloody urine at once; clear after twenty-four hours. Author saw patient first thirteen days after injury. Temperature, 103° F.; large collection of fluid in right loin; lumbar incision; bloody fluid and clots discharged; kidney torn so that one-third was completely free. Nephrectomy; recovery.

Case XXV.—Injury from wagon-wheel. Operation, severe contusion with slight laceration of kidney and injury to ureter; packed and drained. Later, nephrectomy; complete recovery.

Case XXVI.—Fall of six feet, striking upon side. Severe shock for five days. Tumor found extending from ilium to costal border. No operation. Tumor absorbed in five days; recovery after three months.

Case XXVII.—Bland-Sutton.[28] Rupture of kidney; abdominal nephrectomy; recovery.

Case XXVIII.—Turner, G. R.[29] Rupture of kidney in two pieces; abdominal nephrectomy; recovery.

Case XXIX.—Moyniham.[30] Fall down hill. Symptoms of internal hæmorrhage and bloody urine. Operation twelve days later; lumbar nephrectomy and recovery.

Case XXX.[31] Rupture of right kidney; lumbar nephrectomy; recovery.

Case XXXI.—Horse-kick; walked into hospital; pain in abdomen severe; probably intestinal injury. Lumbar incision; kidney torn and bruised; tubular drainage and packed; recovery.

Case XXXII.—Tucker.[32] Man received a crushing injury on streetcar. Admission to hospital two days later; had passed bloody urine previous to admission. Palpation revealed marked tenderness on left side from margins of ribs to crest of ilium; externally, black and blue. No operation; treated by internal medication and rest; recovery.

CASE XXXIII.—Halstead.[33] Injured under wagon-wheel. Severe pain in right abdominal region; pain and deep tenderness and rigidity of abdominal wall; no external evidences of injury.

*Operation.*—Nephrectomy; large hæmatoma about kidney; no blood or urine from the kidney at the time; gauze drain; rupture on convex border of kidney; recovery.

In the general consideration of the subject of subparietal rupture of the kidney, we will first consider:

*Etiology.*—Küster has demonstrated upon the cadaver that rupture of the kidney takes place from hydraulic force, and that whether from direct violence to the body, as from a blow over the loin or the abdomen, the kick of a horse, being run over by a carriage, or from indirect violence, as from a fall. In the words of Küster:[3]

> "The only theory which satisfactorily explains the lacerations of the kidney found after abdominal injuries, which do not cause penetrating wounds, is that of hydraulic pressure, acting through the full vessels and pelvis and causing the organ to burst along lines for the most part radiating from the hylus towards the point of maximum impact of the lower rib, the opposing resistance being supplied by the vertebral column.
>
> "Experiments performed on flaccid kidneys thrown with some force against the floor proved that only superficial grazing or laceration was thus produced.
>
> "On the other hand, when the pelvis and arteries were injected and ligatured, after closure of the vein, and the organ then thrown down, there ensued deep laceration of the kidney substance, the chief tear always taking place between the point of impact and the pelvis, which was not infrequently opened; other rents had a radiating direction. A most important observation in these experiments was that the edges of the rent were everted, and in one case the pelvic fat was forced outward between the edges of the fissured parenchyma. When the force was applied to the convex border, the fissures took a longitudinal direction."

"In prosecuting these experiments further on the human body, Küster found that it is easy to push forward the lower ribs until they touch the kidney, and even force it towards the vertebral column, though on the right side the liver offers some resistance." (Morris.[8])

Güterbock[34] (1895), in 326 autopsies on persons in whom death resulted from accidents, found thirty-six instances of ruptured kidney, representing 10 per cent. of the injuries. Eighty per cent. of the cases occurred in males. One hundred and forty-two of the injuries occurred on the right side and 118 on the left side, twelve being bilateral. In my collection of thirty-four cases, thirty-one were in males, 90 per cent.; three were in females, 104 per cent.; eighteen were of the right kidney, seven were of the left kidney, nine cases not known.

While in a large majority of the cases recorded force of great violence occasioned the rupture of the kidney, it is important to note that in a few instances seemingly forces of lesser degree were adequate to cause this lesion *e. g.* "Those of Campbell,[35] a young girl of fourteen, who doubled up her body forcibly to the left side in jumping a hedge, and immediately experienced severe pain with collapse, and the passage of bloody urine. Also the case of a soldier, who, while boxing with a comrade, was seized with sudden pain, and died of rupture of the kidney." And in one case in my own series, a man, attempting to protect himself from a falling object while loading a wagon, felt a sharp pain in the right side, had almost immediately slight shock, pain, and bloody urine. He recovered without operation.

*The character of the injury* mentioned in the reports of my collection was as follows: Involving the pelvis, thirteen; involving the parenchyma only, eight; part of kidney entirely separated, two; ureter injured, two; vessels injured, three; multiple tears, three; tear of peritoneum, two.

In two cases there was rupture of the spleen; in two, rupture of the liver; in one case there was a fracture of the twelfth rib, and in one there was secondary sepsis.

The author's case was the only one of intestinal injury, and in only one other was such injury suspected and an exploratory laparotomy made. The complications were not specified in the three cases of sudden death.

*Symptoms.*—The symptoms of ruptured kidney are pain, hæmaturia, and tumefaction. The pain, at first severe, is in the region of the kidney, the patient not being able to stand. Later may be added radiating pains to the groin and bladder. The mobile pain, incident to muscular traumatism, either of the back or abdomen, or both, is usually present, and the patient desires to remain in a fixed position. Hæmaturia is present in most of the cases, the exception being in the slight cases and where the ureter is not patent, or is completely ruptured. Tumefaction is generally present, the exception being the slight cases, and the very grave cases of rupture of the peritoneum. Shock is not a characteristic symptom, although it is recorded in many cases. Anæmia, proportionate to the amount of hæmorrhage, is a valuable symptom. Vesical and renal colic, from clots, etc., and alteration in the amount and character of the urinary secretion, may aid in the diagnosis of renal injury.

In my series, hæmaturia was absent in but one of the cases where the urinary symptoms were noted. Tumefaction was noted in twelve cases, but was not mentioned as absent in the others. Shock was mentioned in fifteen cases. Intraperitoneal hæmorrhage in four cases. Pain was noted in seventeen cases, and in many of the others the symptoms were not mentioned. The abstracts in these cases were very deficient in symptomatology.

*Prognosis.*—With the knowledge of the readiness with which clean kidney wounds heal, it is probable that a large number of lesser injuries of that organ recover without the attention of the surgeon, or even the diagnosis of the lesion being made; but of the cases where the diagnosis of rupture cannot be questioned, the mortality has been very great; certainly up to recent times, amounting to one-third of the cases.

The causes of death have been, in the main, from hæmorrhage and sepsis. Shock, nephritis, and anuria claimed a few cases only. Tuffier,[4] in 1888, reports nineteen cases of secondary surgical intervention, with nine recoveries. His table shows that 52 per cent. died after long suppuration and subsequent surgical operation. Keln,[36] in 1894, gives eleven cases of nephrectomy for injury. To this last Wallis[37] adds eleven more. Of twenty-one of these, fourteen were subcutaneous lacerations,—nine recovered and five died (seven were perforating injuries with six recoveries and one death.) In the Billroth Clinic,[2] since the days of antiseptic surgery, the mortality of nephrectomy in general has been 5 per cent., before then it was 35 per cent. Kiemser,[38] from 1881 to 1895, at Seeman's Krankenhause, Hamburg, has ten nephrectomies with two deaths. The author states that the high mortality is due to the lateness of the operation.

Keen[1] reports: 118 cases of rupture; sixty-seven recoveries; fifty deaths; one under treatment at time of report. Mortality of 42.7 per cent. Of the fatal cases, seventeen should be left out for the following reasons:

One case had no other kidney; two cases had injuries of both kidneys; two were found dead; twelve had other complications. Omitting these, gives a general mortality of 33 per cent.

Thirteen early deaths, no nephrectomy; eleven of these from shock and hæmorrhage; two from hæmorrhage, shock and peritonitis; ten late deaths, no nephrectomy; all but two from sepsis; two from hæmorrhage. Had these twenty-three had early nephrectomy, it would probably have reduced the mortality to 23 per cent.

Twenty-two cases of nephrectomy; mortality, 36.4 per cent.

Ninety-five cases, no nephrectomy; mortality, 44.2 per cent., and it was only in the grave cases that nephrectomy was done.

Five cases of primary nephrectomy; one death; 20 per cent.

Thirteen cases, secondary nephrectomy; mortality, 38.5 per cent. Causes of death, primary hæmorrhage and shock, eleven; found dead, two; peritonitis, five; coma, two; pneumonia, one; sepsis and exhaustion, ten; anuria, one; nephritis, one; uncertain, one.

Two cases of partial nephrectomy, with recovery.

In my series of thirty-four cases, there were seven deaths; mortality of 20.5 per cent.

With operations, twenty-six cases, four deaths; mortality, 15.3 per cent.

Without operation, eight cases, three deaths; mortality, 37.5 per cent.

Drainage, nine cases, two deaths; 22.22 per cent. mortality.

Nephrectomy, eighteen cases, two deaths; mortality, 11.11 per cent.; but these two deaths were on acount of hæmorrhage and the operation having been done too late.

Early operations, eighteen cases, one death; mortality, 5.5 per cent.

Late operations, eight cases, three deaths; mortality, 25 per cent.

Of the seven fatal cases, cause of death was in the three unoperated cases: (1) internal hæmorrhage; (2) internal hæmorrhage and shock; (3) peritonitis on third day. Operated cases, internal hæmorrhage and shock from lateness of operation in two cases; in two cases the cause was not given, one dying on the twenty-first day, after drainage of large hæmatoma on tenth day; the other died on second day, following immediate drainage.

*Diagnosis.*—The diagnosis of ruptured kidney is based necessarily on the symptoms of pain, hæmaturia, and tumefaction (and where rupture of the peritoneum is suspected, additional shock and anæmia); but insomuch as the kidney is but one of the anatomical structures injured in a given accident, it is necessary that a careful consideration of the history of each individual case be taken, in order to make the proper inferences as to the tissues most probably injured. A knowledge of the degree, direction, and point of application of the force and the nature of the vulnerating body in direct violence throws as much light on these cases as it does in the study of fractures. The probability as to complications can be strongly conjectured.

In the author's case, the kick from a horse upon the abdomen, a blow of great force, as determined from the history, the patient having been knocked unconscious, with early symptoms of abdominal pain and rigidity, and vomiting, should have suggested serious internal injury and the necessity of operation at once. The operation done in seventy-two hours was in time to save life, but the patient's general condition was not so good as it had been, and the local condition in the abdomen was a threatening rupture of the colon and the presence of bloody fluid in the peritoneal cavity, making the most favorable condition for a general peritonitis.

Gage[39] has shown that where a body, such as a chunk of wood, has been thrown with great velocity, as from a rapidly revolving circular saw, against the abdomen, it should always suggest the probability of internal injury, and that such an accident would lead him to open and thoroughly examine the peritoneal cavity, if the clinical symptoms even suggested the possibility of intestinal rupture.

*Treatment.*—After the diagnosis of ruptured kidney is made the plan of treatment should seem quite clear in view of the history of the work reported in recent years. We should ascertain the full extent of the injury through an iliocostal incision; and if the organ is not irreparably injured, the hæmorrhage should be controlled by the ligature of torn vessels, or, if a parenchymatous oozing, by iodoform gauze packing. If the patient has lost a great deal of blood and there is a question as to whether life can be preserved should further hæmorrhage occur, nephrectomy must not be delayed. But on account of the isolation of the organ in its retroperitoneal fossa, the ease with which it can be brought into view for examination and treatment, without disturbing other structures, together with the good reparative power which it possesses, we should generally pursue a conservative course and try to save the organ rather than to sacrifice it.

As to the management of kidney wounds in general, there are some differences of opinion among operators as to the wisdom of entirely closing them by suture. Believing that the subject is one of importance, I recently addressed letters of inquiry to a few leading surgeons, and through their kindness I am able to briefly report their experiences. The questions were as follows:

1. What has been your experience in complete closure of wounds of kidney (*a*) after nephrotomy in general; (*b*) after accidental wounds of kidney?

2. In what cases either after nephrotomy or after accidental wounds have you drained the kidney?

3. Have you any suggestions to make on the treatment of kidney wounds?

JOSEPH PRICE says: "Complete closure of any kidney wound has been unsatisfactory." He has drained all cases, either accidental wounds or nephrotomy, and suggests to "save as much renal structure as possible by careful surgery and drainage."

N. SENN has never resorted to the suturing of a renal wound.

J. B. MURPHY has found complete closure of kidney satisfactory after nephrotomy, except in suppurative inflammations of the pelvis. He has drained all accidental wounds. Drains the kidney in suppurative cases, and rarely after removal of calculus and in bullet wounds. He says, "I am in favor of treating all contused, incised, and lacerated wounds, except bullet wounds, by accurate suture, absorbable material."

A. D. BEVAN says: "I have closed six or seven kidney wounds completely after nephrolithotomy, and one after operation where the lesion was essential hæmorrhage. Five healed without any leakage. Have not closed any accidental wounds. Would drain all where the ureter was not free, and with gross amount of pus."

Suggestions as to treatment: "Primary closure as above for surgical wounds, nephrotomy for stone, and exploratory; gauze packing for bullet wounds; suture for accidentally incised wounds. Always drain through external incision with cigarette drain, down to point of closure for forty-eight hours."

W. T. BELFIELD considers that complete closure after nephrotomy depends upon degree of infection; in least infected cases, wounds may be closed. Has had no experience in accidental wounds; would drain whenever suppuration was profuse.

L. L. MCARTHUR: "When septic conditions are absent, close renal wound, and drainage for retronephric space, forty-eight to seventy-two hours. Same treatment for accidental wounds."

"Drain all septic and some calculous pyelitis cases with soft, friable stones."

Suggests as to treatment that, "When hæmorrhage is excessive, not easily controlled, packing; remove kidney rather than risk fatal hæmorrhage."

A. J. OCHSNER says: "I have never completely closed a wound of the kidney after nephrotomy, nor after accidental wounds.

"I have drained all nephrotomy wounds for hydronephrosis, circumscribed abscess of the kidney, stone of the kidney and pyelitis, and a number of cases of tuberculosis which were not advanced; also gunshot wounds and also a few excisions of simple cysts in one end of the kidney.

"I have been satisfied with the treatment of kidney wounds by tamponing them with iodoform gauze and removing the tampons, a little at a time, after they became perfectly loose."

M. L. HARRIS writes: "I suture the kidney after nephrotomy in the absence of infection and suppuration, and when there is no interference with the free escape of urine from the kidney. I have never operated for an accidental wound of the kidney.

"I have drained the kidney in the presence of infection and suppuration."

W. J. MAYO: "After clean incisions and wounds of kidney, without infection, I have sutured with catgut and placed no drain in the kidney substance.

"Drain infected cases and lacerated wounds."

"The danger of fistula has led to nephrotomy in clean cases, in which direct incision of the pelvis would have been easier and better. It is the infection of the pelvis that leads to fistula, and in which incision through the kidney substance would prevent this complication."

W. E. MORGAN: "I have never closed a case of nephrotomy or accidental wound."

"In all cases, use drainage."

"I believe in drainage, at least for a reasonable infection period to pass before closure, but might make an exception in exploratory measures where no infection is found, or in some gunshot wounds."

A. I. BOUFFLEUR has closed nonseptic case with satisfactory result. He uses drain only in septic pyelitis. "There is, in my opinion, no valid objection to primary suture of wounds of the kidney. The deep suture should control the hæmorrhage from the incision, which would seem to be the only argument against its use."

My own experience has been to drain every case. I have found it impossible, in the times which I have attempted it, to stop the parenchymatous hæmorrhage perfectly without gauze packing, and I do not consider it safe to suture such a bleeding surface. In the first place, it predisposes to sepsis and urinary extravasation, and in the second place to clots in the kidney pelvis, which may cause serious damage, either by obstructing the ureter or by causing sepsis, which may even extend to the sound kidney. And, lastly, it is contrary to the general surgical rule for the treatment of wounds to suture primarily either a contused or a lacerated wound, and for the reasons stated I think it would be contraindicated in the kidney.

In the treatment of complications, especially those of intraperitoneal structures, the same advance is being made as in the treatment of the kidney by early operation.

The conclusions of B. F. Curtis,[40] in 1887, based upon his experiments upon the cadaver in relation to the mechanical causation of intestinal rupture and upon the theoretical study of one hundred and sixteen cases, with reference to their clinical and pathological aspects, is now shown to be ultra-conservative and erroneous by Homer Gage,[39] who in his conclusions drawn from recent experience says:

"Prompt recognition of the probability of visceral injury, exploratory incision, and the immediate repair of any wounds found in the intestine or mesentery are, I think, the steps which, if carefully, intelligently taken, will enable any one, who has the curiosity to look over the records of these accidents during the next fifteen years, to report a much more brilliant series of results."

My conclusions, based on the cases collected, and my own experience, are as follows:

(1) That the reduction in the mortality since Keen's report has been largely due to improved technique. Fewer deaths have been reported from sepsis. Several deaths have been reported from hæmorrhage which could undoubtedly have been avoided if more prompt and efficient means had been resorted to. I predict that the mortality will be reduced to 15 per cent.

(2) The expectant plan of treatment is permissible in cases where slight hæmaturia is the only symptom. Tumefaction—much blood in the urine, severe pain, and history of great violence, each is a positive indication for prompt operative intervention.

(3) Early operations should be done in all cases where the history of the case and the symptoms point to serious injury of the kidney. (*a*) Nephrotomy, with gauze tamponage, where the patient has not lost enough blood, so that little subsequent hæmorrhage would not endanger life. (*b*) Nephrectomy where the kidney is irreparably injured, and in less extensive injuries where either sepsis or hæmorrhage is likely to prove fatal.

(4) In delayed cases it may be difficult or impossible to know just what is best to do. Every phase of the case must be considered, and then, if in doubt, operate.

(5) Shock is the violent disturbance of the nervous system immediately consequent upon injury. While there is some ground for hesitation in those cases of true shock, most of the

cases described as shock are depression of the vital force from hæmorrhage or sepsis, and nothing short of prompt surgical intervention will prevent collapse.

(6) Operate on the history of the case rather than wait for symptoms which may only suggest what should have been done earlier, but at last proclaim without hope for relief.

## REFERENCES.

[1] Keen, W. W.: Transactions of the American Surgical Association, Philadelphia, 1896, xiv, p. 293. (Dating 1878 to 1897.)
[2] Billroth:
[3] Küster: Surgical Diseases of the Kidneys, Morris, Vol. i, p. 147.
[4] Tuffier:
[5] Grawitz: Langenbeck's Archiv für klinische Chirurgie, Band xxxi, p. 419.
[6] Maas:
[7] Fenger: Journal of American Medical Association, 1889, Vol. xii, p. 901.
[8] Morris: Surgical Diseases of the Kidney, 1901.
[9] Johnson: ANNALS OF SURGERY, 1898, Vol. xxvii, p. 774.
[10] De Kammerer:
[11] Hughes: Transactions of the Philadelphia Pathological Society, 1897-98, p. 181.
[12] Nash: Australasian Medical Gazette, 1897, Vol. xvi, p. 532.
[13] Link: Wiener medicinische Wochenschrift, 1898, Vol. xlviii, p. 481.
[14] Wheeler: Transactions of the Royal Academy of Medicine, Ireland, 1898, Vol. xvi, p. 365.
[15] Brockman: Railway Surgeon, 1898, p. 341.
[16] Heaton: British Medical Journal, 1900, Vol. ii, p. 1108.
[17] Rogers: Ibidem, 1900, Vol. i, p. 15.
[18] Paton: Ibidem, 1900, Vol. i, p. 71.
[19] Bernays: International Clinics, p. 240.
[20] Trimble: Maryland Medical Journal, January, 1901, p. 21.
[21] Hersey:
[22] Rutherford: Glasgow Medical Journal, 1900, Vol. liv, p. 424.
[23] Troynam: West London Medical Journal, 1899, Vol. iv, p. 40.
[24] Gardinier: British Medical Journal, 1900, p. 1779.
[25] Kolliker: Verhandlung der Deutsche Gesellschaft für Chirurgie, 1898, Vol. xxiv, p. 43.
[26] Franz: Deutsche Zeitschrift für Chirurgie, 1897, Vol. xlv, p. 221.
[27] Mudd: Transactions of the American Surgical Association, 1896, Vol. xiv.
[28] Bland-Sutton: Monatsschrift für Unfallheilkunde, 1900.
[29] Turner:
[30] Moyniham: Quarterly Medical Journal, 1898.
[31] Medical Press and Circular, March, 1898.
[32] Tucker: Cook County Hospital Records, Ward 1, 1901.

[33] Halstead: Ibidem, Ward 9, 1901.
[34] Güterbock: Surgical Diseases of the Kidney, Morris, p. 147.
[35] Campbell: Ibidem, p. 145.
[36] Keln:
[37] Wallis:
[38] Kiemser:
[39] Gage, Homer: ANNALS OF SURGERY, 1902, Vol. xxxv, p. 339.
[40] Curtis, B. F.: American Journal of Medical Sciences, 1887, Vol. xciv, p. 322.

## TABLE OF THIRTY-FIVE CASES OF CONTUSION OF THE KIDNEY.

| No. | Injury. | Symptoms. | Lesion. | Complications. | Operation. | Result. | Remarks. |
|---|---|---|---|---|---|---|---|
| 1 | Blow. | Tumor; dull in loin; bloody urine. | Complete rupture. | None. | Third day; nephrectomy; drainage. | Recovery. | .... ............ |
| 2 | ........ | Perinephrectic abscess. | Complete rupture. | None. | Nephrectomy. | Recovery. | .................. |
| 3 | Crushing. | Profound shock; urine, pure blood. | Rupture at pelvis. | Spleen lacerated. | None. | Death. | Peritonitis third day and death. |
| 4 | Horse-kick. | Slight shock; abdominal pain and bloody urine. | Rupture to pelvis. | None. | Sixth day, drained and packed. | Recovery. | Three-eighths of kidney removed. |
| 5 | Horse-kick. | Slight shock; pain; dulness; bloody urine. | Complete rupture. | Secondary sepsis. | Half kidney removed; later, nephrectomy. | Recovery. | 1st operation, fortieth day; 2d, fiftieth day. |
| 6 | Wagon-wheel. | None for one hour, then an internal hæmorrhage; urine clear. | Three tears in kidney. | Liver torn in three places. | None. | Death. | Death in three hours from injury. |
| 7 | Horse-kick. | No external wound; shock; bloody urine. | Complete rupture of kidney and ureter. | Ureter ruptured. | Drained and packed. | Death, third day. | Immediate operation. |
| 8 | Coasting. | Pain in testicle; bloody urine; internal hæmorrhage. | Tear through pelvis. | None. | Drained and packed. | Death, third day. | Immediate operation. |
| 9 | Fall six feet. | Bloody urine; collapse after several hæmorrhages. | Tear of kidney and peritoneum. | Liver ruptured. | Abdominal nephrectomy and packed. | Recovery. | Secondary abscess. |
| 10 | Fall four feet. | Slight shock; later, collapse; internal hæmorrhage; bloody urine. | Double tear of one hilum. | None. | Lumbar nephrectomy and drainage. | Death. | Operation after twenty hours; shock. |
| 11 | Fall. | Slight pain; bloody urine; vomiting; dull in flanks. | ................ | Fracture of twelfth rib. | Drainage of abscess on thirteenth day. | Recovery. | No tear of kidney found at operation. |
| 12 | Fall. | Severe pain; dull in right flank; bloody urine. | Kidney torn from vessels. | None. | Lumbar nephrectomy and packed. | Recovery. | .................. |
| 13 | Fall from train. | After twelve hours, pain in testicle; bloody urine; vomiting and shock. | ................ | ........... | None. | Recovery. | .................. |
| 14 | Fall eighteen feet. | Severe shock; pain in right testicle; bloody urine; tympanitis. | Rupture into pelvis. | None reported. | Lumbar nephrectomy after thirty-six hours. | Death. | Death from shock; no post-mortem examination. |
| 15 | Blow. | Severe pain; bloody urine; dulness to crest of ilium. | Wide tear of kidney. | ........... | Lumbar nephrectomy immediately. | Recovery. | .................. |
| 16 | Wagon-wheel. | General pain; bloody urine; dulness; no shock. | Kidney torn in two halves. | ........... | Lumbar nephrectomy, second day. | Recovery. | .................. |
| 17 | ........ | ............................ | Rupture of kidney. | ........... | Nephrectomy. | Recovery. | .................. |
| 18 | Horse-kick. | Slight shock; severe pain; bloody urine. | Complete tear of kidney. | Tear in spleen. | None. | Death. | Died same day of shock and hæmorrhage. |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 19 | Fall. | Slight pains in side and bladder; bloody urine. | Tear of kidney. | .......... | Drainage on tenth day. | Recovery. | .................. |
| 20 | Muscular contraction. | Bloody urine; pain and tenderness. | .............. | .......... | None. | Recovery. | .................. |
| 21 | Fall. | Slight shock and pain; bloody urine after seventy-two hours. | .............. | Secondary nephritis. | None. | Recovery. | .................. |
| 22 | Fall six feet. | Profound shock; tumor; bloody urine. | Tear half-way through kidney. | .......... | Lumbar drainage on fourteenth day. | Death. | Died twenty-first day. |
| 23 | Fall from sled. | Profound shock; tumor; bloody urine. | Lacerated kidney. | .......... | Lumbar nephrectomy, thirty hours. | Recovery. | .................. |
| 24 | Wagon-wheel. | Profound shock; bloody urine. | One-third of kidney completely separated. | None. | Lumbar nephrectomy on thirteenth day. | Recovery. | .................. |
| 25 | Wagon-wheel. | .......................... | Slight laceration. | Ureter torn. | Primary packing; secondary nephrectomy. | Recovery. | .................. |
| 26 | Fall six feet. | Severe shock for five days; tumor. | .............. | .......... | None. | Recovery. | .................. |
| 27 | ....... | .......................... | Rupture of kidney. | .......... | Abdominal nephrectomy. | Recovery. | .................. |
| 28 | ....... | .......................... | Double rupture of kidney. | .......... | Abdominal nephrectomy. | Recovery. | .................. |
| 29 | Fall down hill. | Internal hæmorrhage; bloody urine. | Rupture of kidney. | None. | Lumbar nephrectomy, twelfth day. | Recovery. | .................. |
| 30 | ....... | .......................... | Rupture of kidney. | .......... | Lumbar nephrectomy immediately. | Recovery. | .................. |
| 31 | Horse-kick. | Slight shock; abdominal pain. | Rupture and bruise of kidney. | .......... | Lumbar drainage immediately. | Recovery. | .................. |
| 32 | Crushing. | Pain in left side; bloody urine; slight shock; slight dulness in abdomen. | .............. | None. | None. | Recovery. | .................. |
| 33 | Wagon-wheel. | Pain in abdomen; no dulness; urine clear. | Rupture on convex border. | None. | Lumbar drainage immediately. | Recovery. | Large hæmatoma around kidney. |
| 34 | ....... | .......................... | Rupture of right kidney. | None. | Exploratory laparotomy; lumbar drainage. | Recovery. | Intestinal injury suspected. |
| 35* | Horse-kick. | .......................... | .............. | .......... | Laparotomy and drainage; lumbar drainage; nephrectomy. | Recovery. | .................. |

---

* Author's case.